On predicting temporal relations: assessing the role of verbal tenses and lexical aspect

In English and French, verbs are obligatorily inflected for tense and grammatical aspect, marking known as *verbal tense* (henceforth, VT). Linguists suggested that VTs, via their semantics, play a significant role for predicting temporal relations (Kamp & Rohrer 1983; van Eijck & Kamp 1997; Moeschler 2000). For example, two situations expressed with a simple past are, most frequently, interpreted chronologically (a forward sequential relation) (1) whereas when an imperfective form is used, the two situations are most frequently interpreted synchronously (2). Another example is that of the pluperfect, which signals that a backward sequential relation between two past situations should be inferred (3).

> (1) Mary *looked* for her key. She *drank* a glass of fresh water.
> (2) Mary *was looking* for her keys. She *drank* a glass of fresh water.
> (3) Marie looked for her key. She had drunk a glass of fresh water.'

Studies on discourse coherence also acknowledged that VTs are cues for coherence relations (Kehler 1994; Das & Taboada 2017). Moreover, scholars working on lexical aspect of situations (roughly, states, activities and events) and discourse structure (Dry 1981; Dowty 1986; Hinrichs 1986) suggested that there is temporal progression with *events* (3) and lack of temporal progression with *activities* (4).

> (4) Mary walked to downtown. She gave her mother a phone call.
> (5) Mary walked along the street. She discussed with her mother on the phone.

To sum up, the VT and the lexical aspect of the verb phrase raise the comprehender's expectation for a sequential or for a synchronous temporal relation. Our **first research question** is: *do VTs and lexical aspect play a significant role for predicting a temporal relation?* On the basis of the state of art, we make the **hypotheses** that the simple past (for VTs) and events (for lexical aspect) trigger most frequently sequential relations whereas the past progressive (for VTs) and activities (for lexical aspect) trigger most frequently synchronous relations. Furthermore, studies suggested that chronological relations are highly expected relations (Segal et al. 1991; Murray 1997; Asr & Demberg 2012). This has been explained in terms of a compliance, during the comprehension process, to the *continuity hypothesis* (when reading a text, readers expect a sentence to be continuous, that is causally or chronologically related, to the previous one). For Asr & Demberg, highly expected relations are most frequently implicit rather than explicit. So, **our second question** is: *are chronological relations more frequently expressed implicitly than overtly marked with a discourse connective?* On the basis of the state of art, we make the **hypothesis** that sequential relations are less frequently overly marked than synchronous or backward relations.

In order to answer these questions, we planned **four annotation experiments** (with 2 annotators) and **one crowd-sourcing evaluation experiment**. In the evaluation experiment disseminated with MTurk, in a 2x4 within-subject design, we manipulate lexical aspect (activities such as *walk along the street* vs. events such as *walk to downtown*) and their four possible configurations: event-event, event-activity, activity-activity and activity-event. The material consists of 34 experimental items ((4) and (5)) and 32 fillers. The task is to read the two segments and to assign them a sequential or a synchronous interpretation by choosing a two-clocks image indicating different times or a two-clocks image indicating the same time. The crowd-sourcing experiment will allow us to assess if lexical aspect predicts the temporal relation, and if it is the lexical aspect from the first segment or from both segments that play a significant role. Data will be analysed using a mixed model, with the temporal relation as dependent variable, lexical aspect and situation configurations as fixed factors, subject and item as random factors.

In the annotation experiments, we use a 5-category annotation scheme of temporal relations (*time advances, time regresses, covering state, same situation* and *time stagnates*) to annotate three sets of data: English elicited data, English corpus data and French corpus data. The **first annotation experiment** is carried out on data (borrowed from Kehler et al. 2008) issued from a continuation task experiment, in which native speakers of English had read sentences expressed with the SP as in (6) and with the PastProg as in (7), and had provided continuations (such as

those in square brackets). 503 continuations were annotated. In our experiment, inter-annotator agreement rate was 73%, which for a 5-category scheme indicates a reliable annotation. The descriptive analysis of the items for which the annotators agreed showed that the SP is most frequently used to express sequential relations (71%) (6). Surprisingly, the PastProg is also used to express most frequently sequential relations (54%) (7). There is no clear-cut association between on the one hand, the SP and sequential relations, and on the other hand between the PastProg and synchronous relations. In terms of inferential statistics, a mixed model will be fitted on the data, with the *temporal relation* as dependent variable, VT as fixed factor, subject and item as random factors.

     (6) Jessica *served* chili to Emily. [Emily did not like it at all.]
     (7) Jessica *was serving* chili to Emily. [Emily did not like it.]
     (8) Jessica (to serve) chili to Emily. [Emily did not like it.]

The **second annotation experiment** is carried out on a similar set of data as in the first experiment, but VTs were removed from the data. Hence, annotators saw the verbs in their bare infinitive form (5). 183 continuations are annotated. The purpose of this experiment is to see whether annotators are capable of identifying temporal relations without having access to the VT. A similar mixed model as in the first experiment will be fitted on the data.

The **third and fourth annotation experiment** are carried out on English and French corpus data (130 excerpts randomly selected from a literary text for each language). For the preliminary results calculated on 48 excerpts (that is, 119 pairs of situations that were temporally related to each other), inter-annotator agreement rate was of 89%. The results indicate chronological relations were less frequently expressed implicitly (34%) than overtly marked with a connective (66%). Synchronous relations are less frequently expressed implicitly (44%) than overtly marked with a connective (56%). For each language, a mixed model will be fitted on the data, with the *temporal relation* as dependent variable, VT and Overt/Implicit status as fixed factors, and item as random factors.

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